AD-A048 732 NAVAL OCEANOGRAPHIC OFFICE WASHINGTON D C F/G 8/3

A NOTE ON SOUND RAY TRACING THROUGH A GULF STREAM EDDY IN THE S--ETC(U)

MAR 74 W GEMMILL, E KHEDOURI

UNCLASSIFIED NOO-TN-6150-21-74 NL

1 OF 1

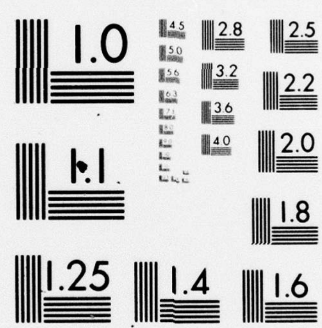
ADA048 732

END

DATE FILMED

2-78

DDC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

CODE NO. ______
COPY NO. ______

A NOTE ON SOUND RAY TRACING THROUGH A GULF STREAM EDDY IN THE SARGASSO SEA

by

W. Gemmill
E. Khedouri

U.S. NAVAL OCEANOGRAPHIC OFFICE
WASHINGTON, D.C. 20373

NAVOCEANO Technical Note 6150-21-74

March 1974

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

(14) NOO-TN-6150-21-74

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER Technical Note 6150-21-74 ✓	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. ~~TITLE (and Subtitle)~~ (6) A Note on Sound Ray Tracing Through a Gulf Stream Eddy in the Sargasso Sea.		5. TYPE OF REPORT & PERIOD COVERED (9) Technical note
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) (10) W./Gemmill E./Khedouri		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Naval Oceanographic Office ✓ Washington, D.C. 20373		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Naval Oceanographic Office Washington, D.C. 20373		12. ~~REPORT DATE~~ (11) March 1974
		13. ~~NUMBER OF PAGES~~ 8
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY ~~CLASS. (of this report)~~ (12) 10p. UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Oceanography	Sargasso Sea
Acoustics	Convergence Zone
Atlantic Ocean	Sound Propagation
Eddies	Deep Sound Channel

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Demonstrates the effects of a cold Gulf Stream eddy on convergence mode sound propagation. The eddy refracts sound rays into the deep sound channel and destroys cyclic convergence zones.

ABSTRACT

This note demonstrates the effects of a cold Gulf Stream eddy in the Sargasso Sea on convergence mode sound propagation. Results indicate that an eddy refracts the sound rays into the deep sound channel and destroys the cyclic convergence zones typically observed in the area.

FIGURES

Sargasso Sea is an ideal water mass for long range sound propagation study because its horizontal thermohaline structure is homogeneous over long distances, and because sound rays typically propagate with recurring convergence zones. However, recent papers by Parker (1971) and Gotthardt (1973) reveal that Gulf Stream rings (eddies), which alter physical properties and sound propagation characteristics of the area, are common throughout the northwestern portion of Sargasso Sea. These eddies of colder and less saline water than the surrounding water mass are typically about 200 kilometers in diameter and 1500 meters deep. They drift slowly southwestward for periods of up to one year before sinking or being recaptured by the Gulf Stream.

This note demonstrates the effects of an eddy on sound propagation by comparing sound rays originating from a source in the Sargasso Sea, passing through a cold eddy and re-entering the Sargasso Sea, to sound rays originating from the same source, passing through the same geographical region, but without the eddy. A similar study was made by Vastano and Owens (1973), however, the sound source was placed at the center of a cold ring with sound rays propagating into warmer surrounding water.

Figure 1 shows the vertical sound speed structure through a cold eddy surveyed north of Bermuda in February 1973. This eddy was exceptionally large; its diameter was nearly 360 kilometers and it extended to below the maximum depth of available data which was 2500 meters. Sound speeds calculated from temperature, salinity, and depth data using Wilson's equation (1960), reflect thermohaline changes across the eddy. Axial depth of the deep sound channel (DSC), defined as the depth of minimum sound speed, shows an abrupt change from 1200 meters depth in the Sargasso

Sea to 700 meters in the center of the eddy. Sound speed change along the axis of the deep sound channel is only 6 m sec^{-1}. However, sound speed changes of 30 m sec^{-1} are seen at a constant depth of 600 meters across the eddy.

Selected sound speed profiles for this demonstration are shown in figure 2. For ray tracing purposes the sound speeds were extended from 2500 meters (the deepest data point) to the bottom, by interpolating between the values at 2500 meters and the historical bottom sound speed values for this region.

To study the eddy's impact on sound propagation, the NOL ray tracing model (Goodin, 1970) was used with a sound source at 20 meters depth and located 45 kilometers from the eddy edge. Sound rays were plotted at 0.5 degree intervals from the horizontal to 9.5 degrees downward. Rays which initially bounced off the bottom were excluded to present a clearer ray diagram for convergence zone mode of sound propagation. Two cases were studied: the first assumes only Sargasso Water (figure 3a) and the second assumes Sargasso Water with the cold eddy in the sound path (figure 3b). It can be seen that the eddy destroys the cyclic convergence zones which typically occur at 70 kilometer intervals and refracts the sound into the deep sound channel.

These results suggest that cold eddies in the Sargasso Sea have a pronounced effect on sound propagation; sufficiently so that if an eddy occurs between a shallow sound source and a receiver, the sound source could go undetected near the surface, but the detection capability could be improved if the receiver is placed near the deep sound channel axis. Field experiments to test these results further are planned.

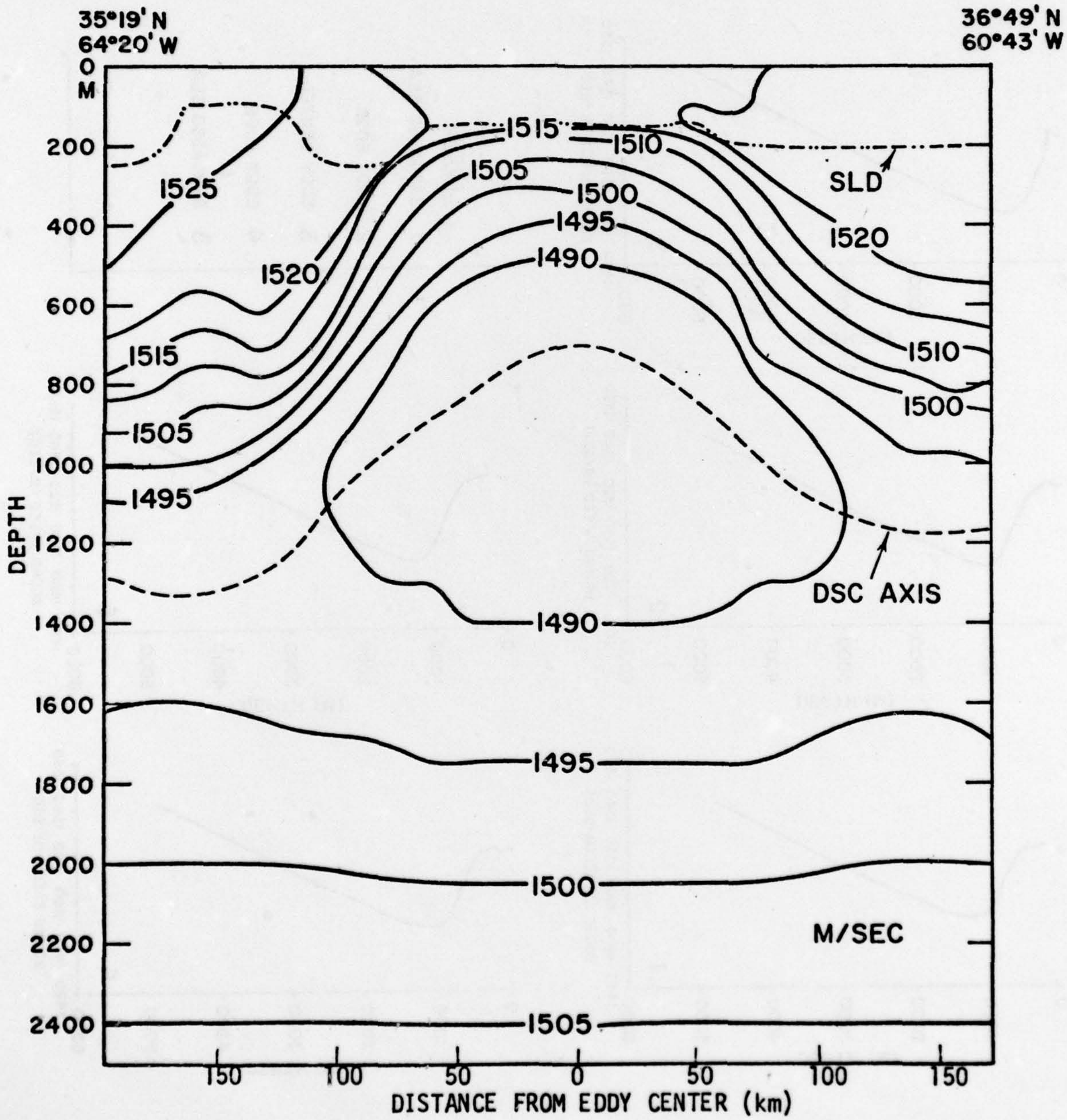


Figure 1 - Vertical sound speed section through a cold eddy

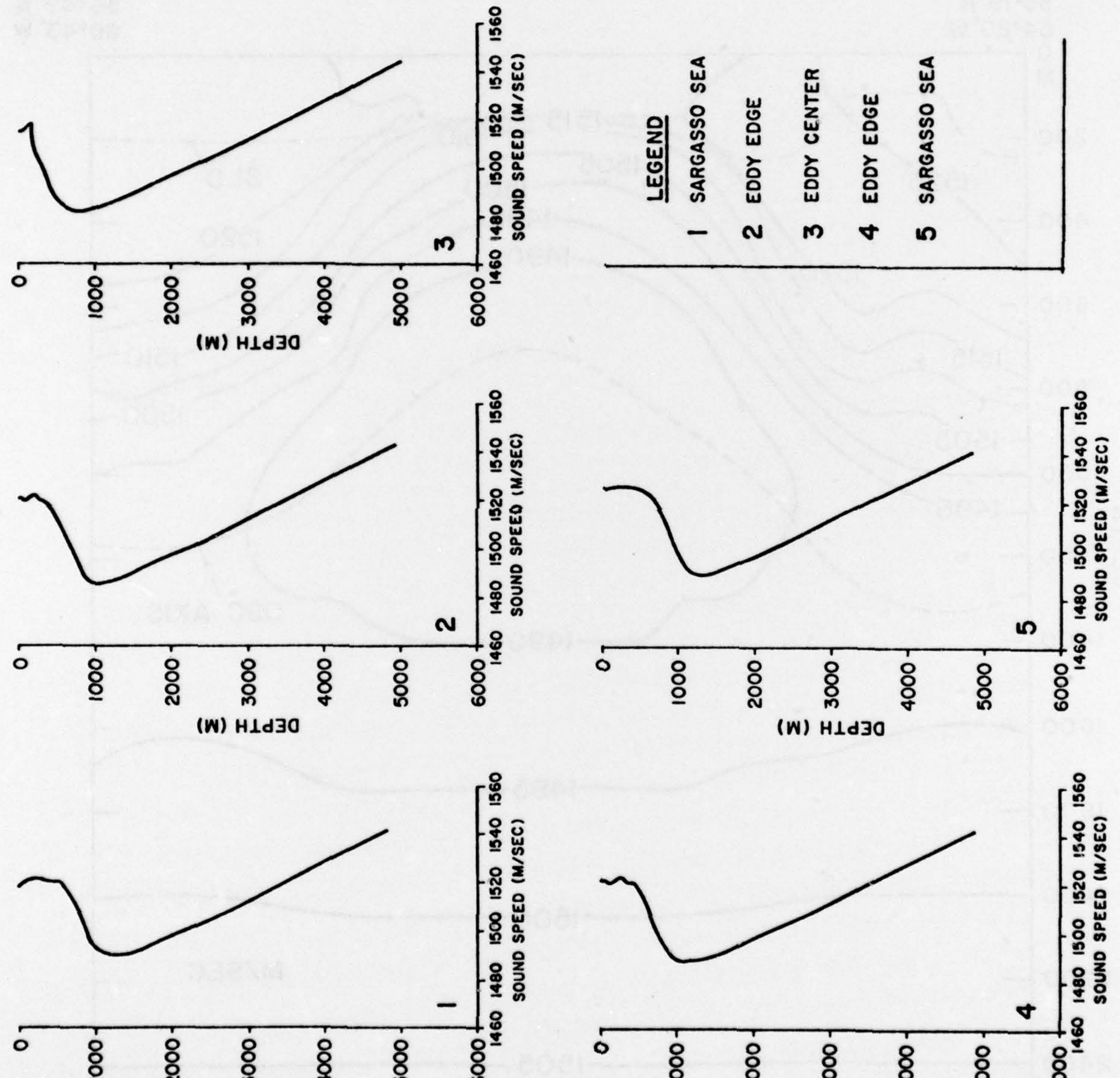


Figure 2 - Selected sound speed profiles

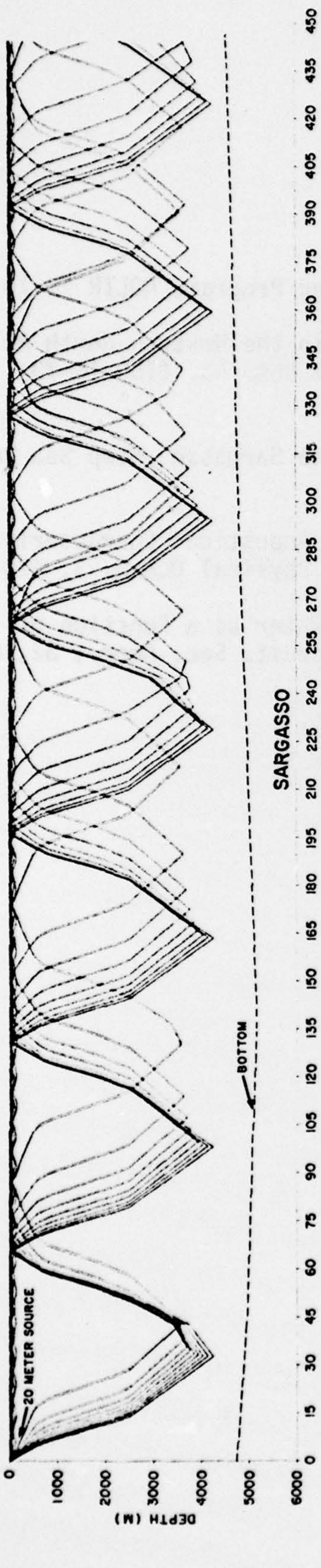


Figure 3a - Ray diagram of sound paths through the Sargasso Sea

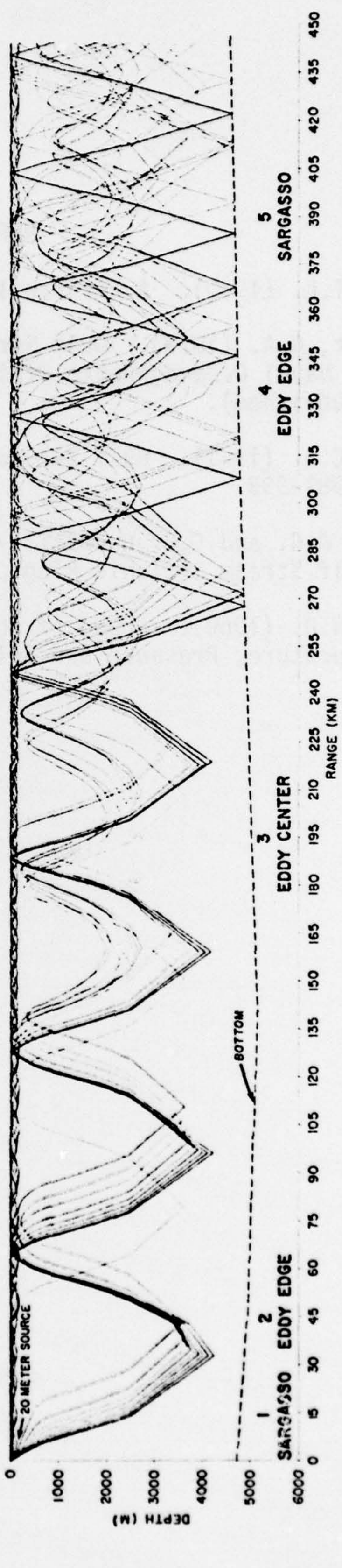


Figure 3b - Ray diagram of sound path through a cold eddy in the Sargasso Sea

REFERENCES

Goodin, T.L. (1970). A Fortran IV Ray Tracing Program, NOLTR 70-74, 24 pp.

Gotthardt, G.A. (1973). Gulf Stream Eddies in the Western North Atlantic, U.S. Naval Oceanographic Office Technical Note No. 6150-16-73 (unpublished).

Parker, C.E. (1971). Gulf Stream rings in the Sargasso, Deep Sea Res., 18, 981-993.

Vastano, A.C. and G.E. Owens (1973). On the Acoustical Characteristics of A Gulf Stream Cyclonic Ring. Journal of Physical Ocean. 3, 470-478.

Wilson, W.D. (1960). Speed of sound in Sea Water as a Function of Temperature, Pressure and Salinity, J. Acoust. Soc. Amer., 32, 641-644.

DISTRIBUTION LIST

DATE: March 1974 6150-21-74

SUBJECT: A Note on Sound Ray Tracing through a Gulf Stream Eddy in the Sargasso Sea

TECHNICAL NOTE 6150-21-74	EVALUATION REPORT
PROGRESS/STATUS REPORT	OTHER
SYSTEMS ANALYSIS REPORT	
LETTER	

CLASSIFICATION: Unclassified NUMBER OF COPIES MADE: 25

COPY NO.	(Internal)	COPY NO.	
1	Code 00	21	
2	Code 01	22	
3	Code 011	23	
4	Code 3000	[illegible]	
5	Code 6000	[illegible]	
6	Code 6002		
7	Code 6100		
8	Code 6110		
	Code 6130		
	Code 6150		
	Code 6151		
	Code 6152		
13	Code 6160		
14	NAVOCEANO Rep. (Mr. S. Lazanoff)		
15			
16			
17			
18			
19			
20			

REMARKS: